Claims

Having described the preferred embodiments, the invention is now claimed to be:

1. A magnetic resonance method including:

performing a blood-nulling magnetic resonance excitation sequence **(70)** that substantially nulls a magnetic resonance signal from blood; and

subsequent to the performing of the blood-nulling magnetic resonance excitation sequence **(70)**, performing a readout magnetic resonance sequence **(72)** to acquire a magnetic resonance signal from tissue other than the nulled blood.

2. The magnetic resonance method as set forth in claim **1**, wherein the performing of a blood-nulling magnetic resonance sequence **(70)** includes:

performing an inversion recovery magnetic resonance excitation sequence **(70)** having an inversion time **(60)** to substantially null the magnetic resonance signal from blood.

3. The magnetic resonance method as set forth in claim **2**, wherein the performing of an inversion recovery magnetic resonance sequence **(70)** includes:

applying an inversion radio frequency pulse **(74)**;

delaying for the inversion time **(60)**; and

applying an excitation radio frequency pulse **(80)**.

4. The magnetic resonance method as set forth in claim **3**, wherein:

the applying of the inversion radio frequency pulse **(74)** is performed without an accompanying spatially selective magnetic gradient pulse; and

the applying of the excitation radio frequency pulse **(80)** is performed with an accompanying spatially selective magnetic field gradient pulse **(82)**.

5. The magnetic resonance method as set forth in claim **3**, wherein the performing of an inversion recovery magnetic resonance sequence **(70)** further includes:

applying additional inversion radio frequency pulses to maintain blood in a substantially nulled condition.

6. The magnetic resonance method as set forth in claim **3**, wherein the inversion radio frequency pulse **(74)** is a 180° pulse and the excitation radio frequency pulse **(80)** is a 90° pulse.

7. The magnetic resonance method as set forth in claim **2**, further including determining the inversion time **(60)** for nulling blood by:

determining a T1 value of blood; and

selecting the inversion time **(60)** for substantial blood nulling based on the determined T1 value of blood.

8. The magnetic resonance method as set forth in claim **7**, wherein the determining of a T1 value of blood includes:

acquiring a representative blood sample; and

measuring the T1 value of the representative blood sample.

9. The magnetic resonance method as set forth in claim **7**, wherein the determining of a T1 value of blood further includes:

determining a hematocrit of the blood; and

correcting the T1 value of blood for the determined hematocrit.

10. The magnetic resonance method as set forth in claim **2**, further including:

identifying at least a main magnetic field strength and a repeat time; and

determining the inversion time **(60)** for nulling blood based on a predetermined relationship **(64)** between the inversion time for nulling the blood and the identified main magnetic field strength and repeat time.

11. The magnetic resonance method as set forth in claim **2**, further including:

optimizing an inversion time of a calibration inversion recovery magnetic resonance excitation sequence to minimize a magnetic resonance signal of a large blood vessel; and

selecting **(66)** the inversion time **(60)** for nulling blood as the optimized inversion time of the calibration inversion recovery magnetic resonance excitation sequence.

12. The magnetic resonance method as set forth in claim **2**, further including:

generating a reconstructed image from the acquired magnetic resonance signal.

13. The magnetic resonance method as set forth in claim **12**, further including:

subsequent to performing the readout magnetic resonance sequence, inducing a physiological perturbation;

subsequent to inducing the physiological perturbation, repeating performing the inversion recovery magnetic resonance excitation sequence **(70)** and performing the readout

magnetic resonance sequence **(72)** to acquire a second magnetic resonance signal from tissue other than the nulled blood; and

generating a perturbation reconstructed image from the acquired second magnetic resonance signal.

14. The magnetic resonance method as set forth in claim **12**, further including:

subsequent to performing the readout magnetic resonance sequence **(72)**, inducing a physiological perturbation;

subsequent to inducing the physiological perturbation, repeating performing the inversion recovery magnetic resonance excitation sequence **(70)**;

subsequent to repeating the performing of the inversion recovery magnetic resonance excitation sequence **(70)**, performing a plurality of readout magnetic resonance sequences **(72)** each having a different echo time to acquire a plurality of magnetic resonance signals corresponding to the plurality of echo times;

generating a plurality of perturbation reconstructed images from the acquired plurality of magnetic resonance signals corresponding to the plurality of echo times; and

determining a temporal evolution of a physiological response to the physiological perturbation based on the plurality of perturbation reconstructed images.

15. The magnetic resonance method as set forth in claim **14**, wherein the determining of a temporal evolution includes:

computing a change in vascular space occupancy signal between perturbation reconstructed images and corresponding unperturbed reconstructed images for each echo time to produce change in vascular space occupancy signal versus echo time data **(106)**; and

fitting the change in vascular space occupancy signal versus echo time data **(106)** to a mathematical model to obtain a blood volume parameter value **(118)**.

16. The magnetic resonance method as set forth in claim **12**, further including:

determining a T1 value of tissue **(132, 134)**;

computing a tissue magnetization (M) based on the T1 value of the tissue **(132, 134)**;

generating a normalized reconstructed image **(142)** by dividing the reconstructed image by the tissue magnetization; and

estimating a blood volume parameter value **(146)** based on the normalized reconstructed image **(142)**.

17. The magnetic resonance method as set forth in claim **16**, wherein the reconstructed image corresponds to a subject brain region, and determining the T1 value of the tissue **(132, 134)** includes:

determining a first T1 value **(132)** corresponding to white brain matter; and

determining a second T1 value **(134)** corresponding to gray brain matter;

wherein the dividing of the reconstructed image by the tissue magnetization uses for each image element a selected one of the first and second T1 values **(132, 134)** based on a classification of local tissue type as one of gray brain matter and white brain matter.

18. The magnetic resonance method as set forth in claim **12**, wherein performing the readout magnetic resonance sequence **(72)** effects imaging of a subject brain region of a subject brain, and the method further includes:

providing a reference image **(152)** of a reference brain region; and

comparing the reconstructed image with the reference image **(152)** to detect an abnormality of the subject brain region.

19. The magnetic resonance method as set forth in claim **18**, wherein providing the reference image **(152)** of a reference brain region includes repeating:

performing the inversion recovery magnetic resonance excitation sequence **(70)**,

performing the readout magnetic resonance sequence **(72)**, and

generating the reconstructed image on the reference brain region to generate the reference image **(152)**.

20. The magnetic resonance method as set forth in claim **19**, wherein the reference brain region is selected from a group consisting of:

a brain region of a contralateral side of the subject brain corresponding to the subject brain region,

a brain region of a brain other than the subject brain which corresponds to the subject brain region, and

a brain region of the subject brain other than the subject brain region.

21. The magnetic resonance method as set forth in claim **12**, further including:

computing at least one of a proton density weighting of tissue, a T1 weighting of tissue, and a T2 weighting of tissue without interference from a magnetic resonance signal of blood based on the reconstructed image.

22. The magnetic resonance method as set forth in claim **2**, wherein performing the readout magnetic resonance sequence **(72)** includes performing one or more of:

a single-shot imaging sequence,

a single-shot echo planar sequence,

a multi-shot imaging sequence,

a spectroscopy sequence,

a multiple slice image,

a one-dimensional, two-dimensional, or three dimensional spatial encoding sequence,

a fractional k-space acquisition sequence,

a spin echo readout sequence, and

a gradient echo readout sequence.

23. A magnetic resonance system including:

a blood nulling means **(10, 12, 16, 18, 30, 32, 34)** for performing a blood nulling magnetic resonance excitation sequence **(70)** that substantially nulls a magnetic resonance signal from blood; and

a readout means **(10, 12, 16, 18, 30, 32, 36)** for performing a readout magnetic resonance sequence **(72)** to acquire a magnetic resonance signal from tissue other than the nulled blood, the readout means **(10, 12, 16, 18, 30, 32, 36)** operating subsequent to operation of the blood nulling means **(10, 12, 16, 18, 30, 32, 34)**.

24. The magnetic resonance system as set forth in claim **23**, wherein the blood nulling means **(10, 12, 16, 18, 30, 32, 34)** includes:

an inversion recovery means **(10, 12, 16, 18, 30, 32, 34)** for performing an inversion recovery magnetic resonance excitation sequence **(70)** having an inversion time **(60)** in which magnetic resonance of blood is substantially nulled.

25. The magnetic resonance system as set forth in claim **24**, further including:

a means **(64)** for determining the inversion time **(60)** based on a set of values including at least a magnetic field strength value and a repeat time value.

26. The magnetic resonance system as set forth in claim **24**, further including:

a means **(62)** for measuring a T1 value of blood, the inversion time **(60)** being obtained from the measured T1 value of blood.

27. The magnetic resonance system as set forth in claim **24**, further including:

a reconstruction means **(44)** for generating a reconstructed image from the acquired magnetic resonance signal.

28. The magnetic resonance system as set forth in claim **27**, further including:

a means **(100, 130)** for computing a blood volume parameter value **(118, 146)** from the reconstructed image.

29. The magnetic resonance system as set forth in claim **28**, wherein the means **(130)** for computing a blood volume parameter value **(118, 146)** includes:

a means **(136, 140)** for normalizing the reconstructed image based on a T1 value of tissue **(132, 134)** to generate a tissue-normalized reconstructed image; and

a means **(144)** for computing the blood volume from the tissue-normalized reconstructed image.

30. The magnetic resonance system as set forth in claim **28**, wherein the means **(100)** for computing a blood volume parameter value **(118, 146)** includes:

a means **(104)** for computing an intermediate parameter **(106)** functionally related to blood volume for a plurality of reconstructed images produced by repetitively invoking the readout means and the reconstruction means with a corresponding plurality of echo times **(102)**; and

a means **(110)** for fitting a parameterized model to the intermediate parameters **(106)** and the corresponding echo times **(102)**, the parameterized model having parameters including a rest blood volume **(118)** and a blood volume change **(124)**.

31. The magnetic resonance system as set forth in claim **27**, further including:

a means **(154)** for combining the reconstructed image with a reference image **(152)** to identify an abnormality in the reconstructed image.